Post-combustion Capture:

now the best option?

A Symbiosis of Power Plant Design and Separation Science

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State-of-the-art of post-combustion scrubbing is not competitive!

Reasons:

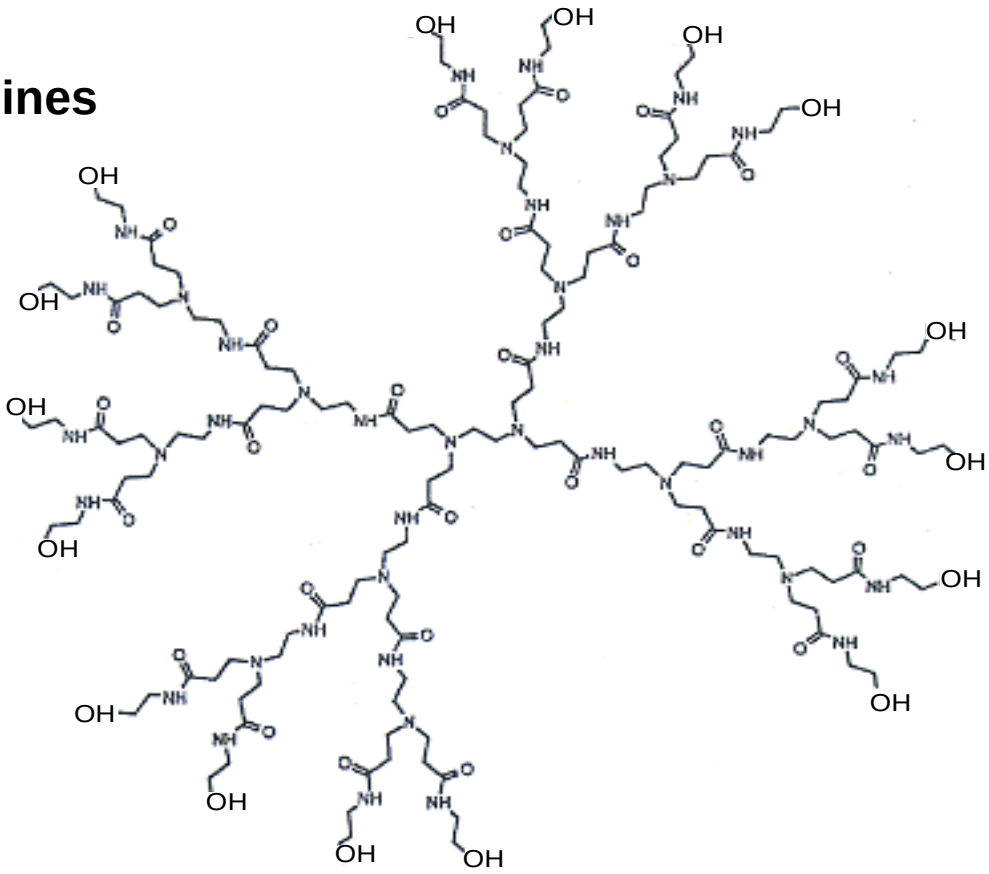
1. Chemical reactive solvents not needed and too energy consuming
2. Scrubbing added not integrated into power plant

Way-out:

1. balance the solubility/energy consumption by means of thermodynamics
2. simulate a power plant in the chemical engineering software (Aspen Plus®) and optimize the configuration: process synthesis

Drawbacks of CO_2 absorption with Amines

- high energy penalty
- volatility
- degradation losses (O_2, NOx, SO_2)
- corrosion



Tailor a suitable solvent by thermody

balanced physical absorption

high capacity & selectivity

“no” vapor pressure

no carbamate reaction

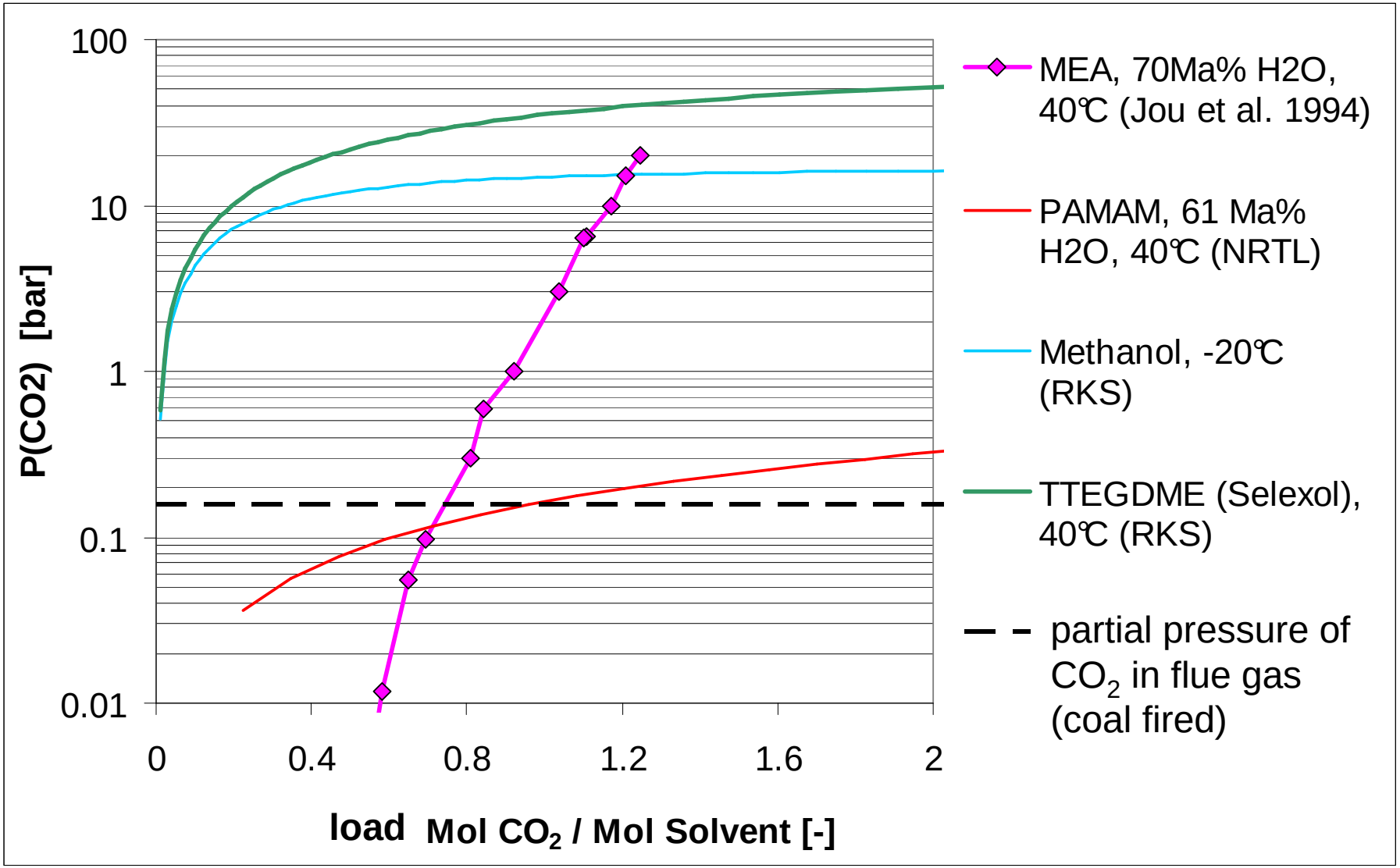
available on ton scale @ reasonable price

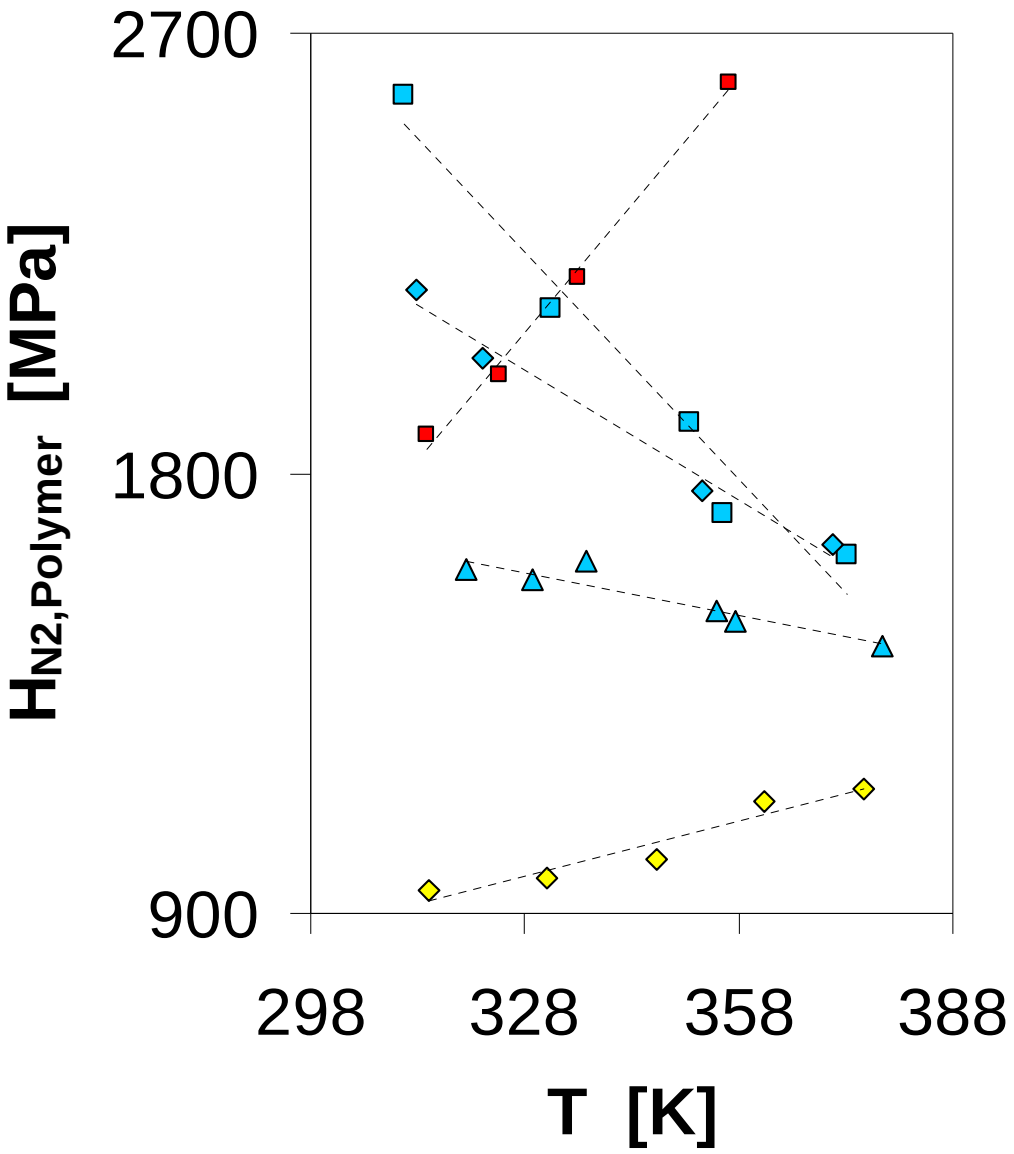
Still to check:

Compatibility towards other components

hyperbranched poly-amide (Dendritech)

to be published in Industrial and Engineering Chemistry Research (2007)


100
10
1
0.1
0.01
P(CO2) [bar]
0
0.4
0.8
1.2
1.6
2
load Mol CO2 / Mol Solvent [-]
MEA, 70Ma% H2O, 40℃ (Jou et al. 1994)
PAMAM, 61 Ma% H2O, 40℃ (NRTL)
Methanol, -20℃ (RKS)
TTEGDME (Selexol), 40℃ (RKS)
partial pressure of CO2 in flue gas (coal fired)



hyperbranched polymers

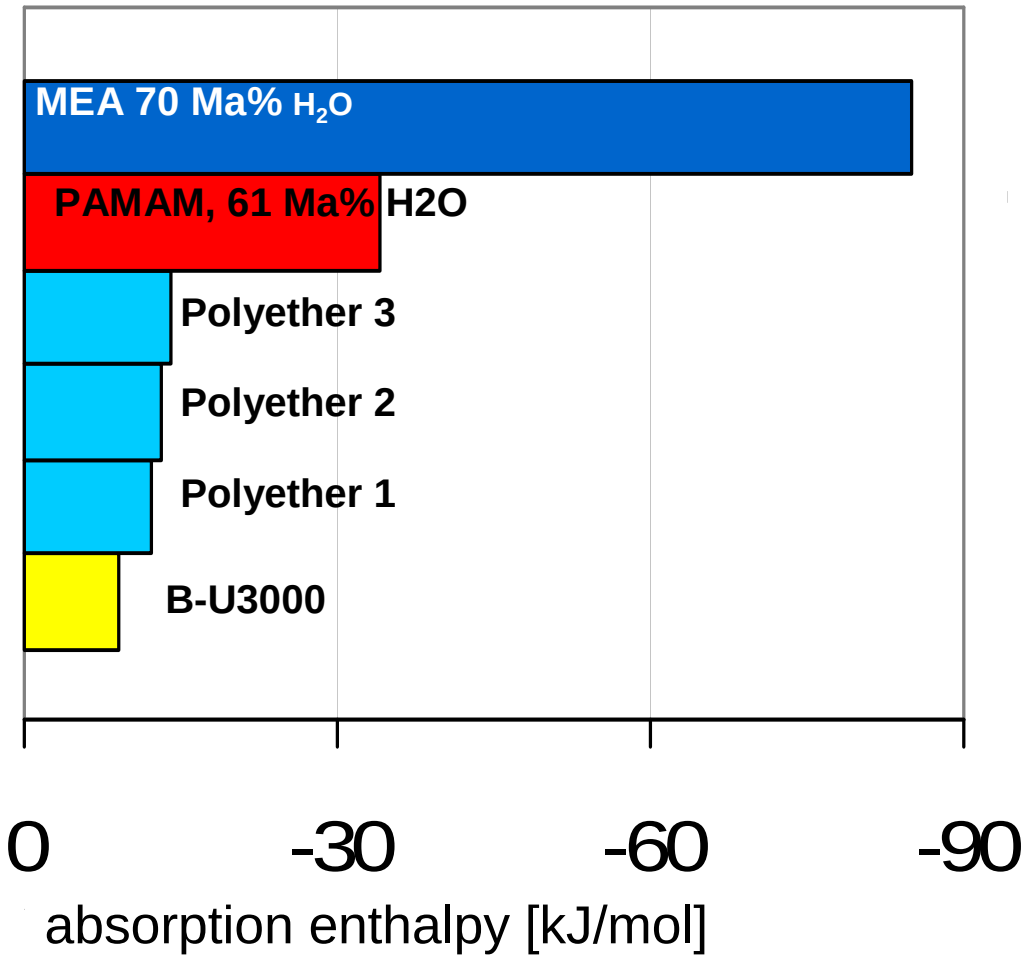
Polyester

Polyether

Polyamine

conclusion:

difference in solubility to CO_2 by factor of 80

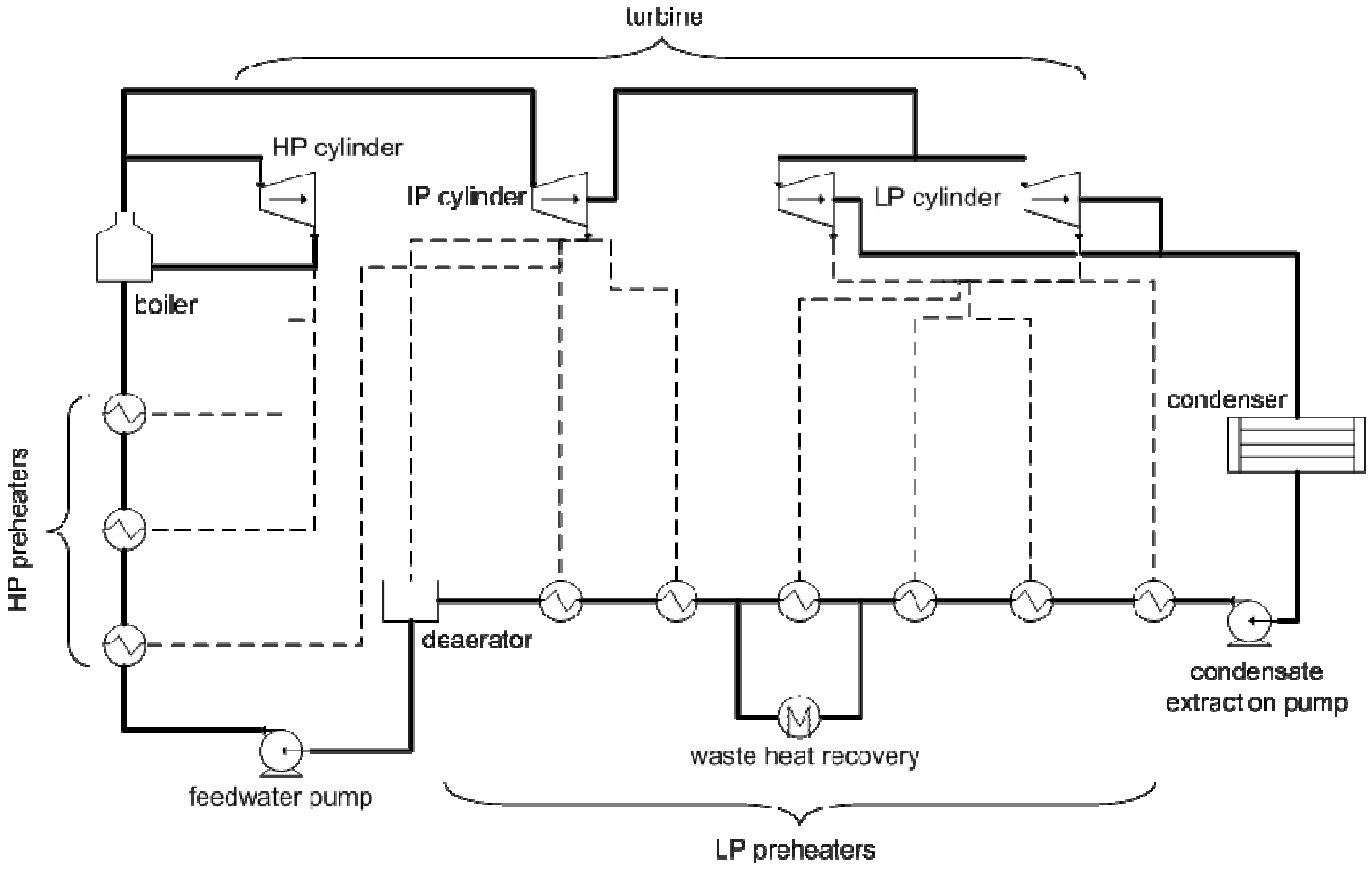

MEA 70 Ma% H2O
PAMAM, 61 Ma% H2O
Polyether 3
Polyether 2
Polyether 1
B-U3000
0
-30
-60
-90
absorption enthalpy [kJ/mol]

Steam cycle of supercritical steam process
280bar / 600℃ / 620℃ (lignite)

1000 MW_{el}
η=49% (LHV)
964 kg/s flue gas
209,1 kg/s CO_2

<u>Flue gas:</u>

N_2:	71,7 Mol%
CO_2:	14,6 Mol%
H_2O:	9,5 Mol%
O_2:	3,4 Mol%
Ar:	0,9 Mol%



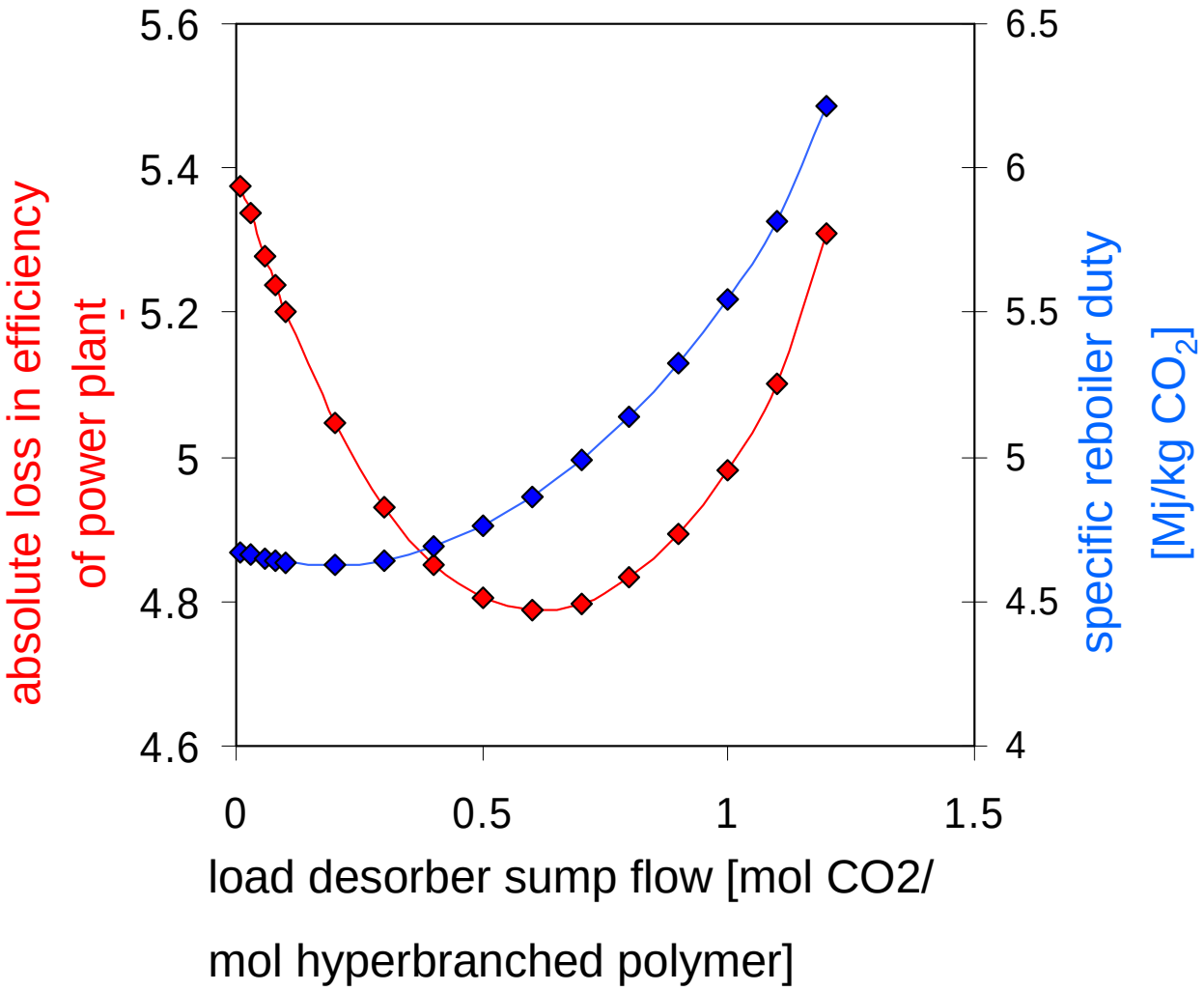
Output Variable	Deviation	
	absolute	relative
Temperature boiler outlet	1.4 K	0.16%
HP outlet	1.2 K	0.20%
boiler (reheater) outlet	1.6 K	0.18%
IP outlet	2.6 K	0.52%
LP outlet	0.0 K	0.00%
Gross electric power output	1.25 MW	0.13%
Net electric power output	1.25 MW	0.14%
Gross electric efficiency	0.06 %pts	0.11%
Net electric efficiency	0.07 %pts	0.14%

The following slides showed the penalty of power plant efficiency over the capture rate of CO_2.

These data are available after having made a secrecy agreeement with Prof.Arlt. Please write to Wolfgang.Arlt@CBI.Uni-Erlangen.de

slides removed

hyperbranched polymer, 60% CO_2 recovery



- a chemically reacting scrubbing solvent is not helpful for efficient removal of CO_2 from flue gas of coal-fired power stations: a new class of solvent detected

- the present energy cycle process set-up is optimized, a scrubbing unit can NOT be simply added: a superior set-up was found

- a recovery rate of CO_2 is subject to optimization and NOT to political presetting

- at 50% CO_2 recovery less than 3% abs. efficiency drop is possible (without liquefication of CO_2).

what to do?

the rules are established, a cheap and robust real scrubbing agent must be found with the help of chemistry

With this work, post-combustion scrubbing is superior to IGCC and oxy-fuel